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When $y=b$, $\frac{dx}{dt}=0$, $\frac{dy}{dt}=0$, $\frac{d\theta}{dt}=0$; $\therefore C=2mgb$, and we have

$$\frac{dx^2}{dt^2} + \frac{dy^2}{dt^2} + k^2 \frac{d\theta^2}{dt^2} = 2g(b-y) \dots (1).$$

Now $x=a-\theta r \sin \alpha \cos \beta$, $y=b-\theta r \sin \alpha \sin \beta$; then

$$\frac{dx}{dt} = -r \sin \alpha \cos \beta \frac{d\theta}{dt}, \quad \frac{dy}{dt} = -r \sin \alpha \sin \beta \frac{d\theta}{dt}, \quad \frac{dx^2 + dy^2}{dt^2} = r^2 \sin^2 \alpha \frac{d\theta^2}{dt^2}; \text{ then}$$

$$k^2 \frac{d\theta^2}{dt^2} = \frac{k^2}{r^2 \sin^2 \alpha} \cdot \frac{dx^2 + dy^2}{dt^2}.$$

Substituting in (1),

$$\frac{dx^2 + dy^2}{dt^2} \cdot \frac{r^2 \sin^2 \alpha + k^2}{r^2 \sin^2 \alpha} = 2g(b-y) = 2g\theta r \sin \alpha \sin \beta \dots (2).$$

But $dx^2 + dy^2 = ds^2$, in which $s = \theta r \sin \alpha$, or $ds = r \sin \alpha d\theta$; \therefore (2) becomes

$$\frac{ds^2}{dt^2} = \frac{2r^2 \sin^2 \alpha}{r^2 \sin^2 \alpha + k^2} g s \sin \beta \dots (3).$$

Taking the derivative of both members of (3) with respect to t , dividing by $\frac{ds}{dt}$, multiplying by dt and integrating twice, noticing that when $t=0$, $\frac{ds}{dt}=0$, and $s=0$, and finally putting $s=l$ =the length of the trough,

$$s = \frac{1}{2} \frac{r^2 \sin^2 \alpha}{r^2 \sin^2 \alpha + k^2} g t^2, \text{ whence } t = \frac{1}{\sin \alpha} \sqrt{\frac{(10 \sin^2 \alpha + 4)l}{5g \sin \beta}}, k^2 \text{ being } \frac{2}{3} r^2.$$

Also solved by G. B. M. Zerr and G. W. Greenwood.

DIOPHANTINE ANALYSIS.

136 Proposed by A H HOLMES, Brunswick, Maine.

In the equation in Diophantine Analysis: $2x^2 + 2x + 1 = \square = u^2$, show that u is always the sum of two squares.

Solution by L. E. NEWCOMB, Los Gatos, Cal.

$$2x^2 + 2x + 1 = x^2 + (x+1)^2 \dots (1).$$

Let $pq=x$ or $pq=x+1$ according as x is odd or even; then, for all integral values of x that satisfy (1), $\frac{1}{2}p^2 - \frac{1}{2}q^2 = x+1$ or $\frac{1}{2}p^2 - \frac{1}{2}q^2 = x$.

$$\therefore p^2 q^2 + (\frac{1}{2}p^2 - \frac{1}{2}q^2)^2 = x^2 + (x+1)^2 = u^2.$$

But $p^2 q^2 + (\frac{1}{2}p^2 - \frac{1}{2}q^2)^2 = (\frac{1}{2}p^2 + \frac{1}{2}q^2)$. For p , substitute $m+n$, for q , $m-n$; then $(\frac{1}{2}p^2 + \frac{1}{2}q^2)^2$ becomes $(m^2 + n^2)^2$. Since $(m^2 + n^2)^2 = u^2$, $u = m^2 + n^2$, the sum of two squares.